

30-September-2020

David Albright  
Manager, Groundwater Protection Section  
U.S. Environmental Protection Agency, Region IX  
75 Hawthorne Street  
San Francisco, California 94105

RE: Response to Technical Evaluation Comments and Information Request  
for Underground Injection Control (UIC) Permit Application  
Class VI Pre-Construction Permit Application No. R9UIC-CA6-FY20-1

Dear Mr. Albright,

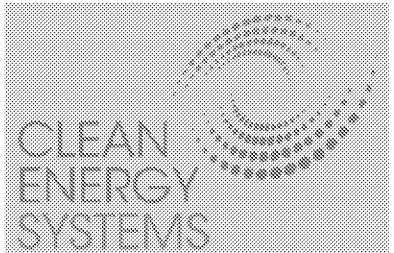
Clean Energy Systems, Inc. (CES) thanks you and the staff at the United States Environmental Protection Agency (EPA) for your consideration and review of our Class VI Pre-Construction Underground Injection Control Permit Application for the Mendota site.

This letter and enclosures are in response to your recent Comments and Information Request based upon the technical evaluation of the geologic site characterization information provided in the subject permit application, dated 19-August-2020. The enclosures are organized into two sections, a detailed technical response and Appendices containing information supporting considerations of specific federal laws.

CES worked with subsurface experts at Schlumberger to develop the technical response section. The section begins with additional information on the geologic formation use and supplemental figures to support EPA's review and evaluation of the subject application. It then provides direct responses to EPA's comments and information requests. For completeness, CES elected to write our responses within EPA's Site Characterization Evaluation Enclosure; CES responses are in *green font*. Requested Updated Figures are included in Appendix A.

CES recognizes the interests of the EPA in ensuring that potential impacts caused by the project to wildlife protected under the Endangered Species Act (ESA) and to historical features preserved under the National Historic Preservation Act (NHPA) are identified and addressed. Appendix B and C contain a copy of the proposals from two consulting firms hired by CES, with expertise in these matters. CES has conferred with the expert consultants and emphasized the need to fully address California Environmental Quality Act (CEQA) requirements as well as pertinent federal requirements identified in

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the 19-August-2020 EPA letter. Both firms responded by expressing their familiarity with these needs.

To protect confidential business information (CBI), a version with CBI removed will be submitted through the EPA's online Geologic Sequestration (GS) Data Tool, while a second version, containing CBI, will be transmitted through a secure means to EPA.

If you have any questions related to the content of this response or wish to discuss these matters further, I can be reached via email at [rhollis@cleanenergysystems.com](mailto:rhollis@cleanenergysystems.com).

Sincerely,



Rebecca M. Hollis  
CES Director of Business Development – CNE

**Enclosures**

CC (via email):      Keith Pronske, CES President & CEO  
                              Natalie Nowiski, Schlumberger NE CCS BD and Legal Counsel  
                              Vivian Rohrback, Schlumberger SIS Project Manager

# ENCLOSURE

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# 1 Additional Information on Formation Use and Supplemental Figures

Clean Energy would like to further clarify the regional geology and formation use at the Mendota Site. The below section and figures are meant to give additional context or replace figures previously submitted. These figures will be incorporated into the final version of the Narrative once all feedback is received from the EPA. Table 1 below summarizes the primary formations of interest at the Mendota Site and how they are intended to be used for this project. Table 2 summarizes inconsistencies that the EPA identified for which specific questions were not asked.

<b>Primary Formations of Interest</b>	<b>Formation Description and Intended Use</b>
<b>Garzas Sandstone</b>	The Garzas sandstone member of the Moreno formation represents a major deltaic complex and overlies the Moreno Shale. This zone will be monitored for above confining zone migration of CO <sub>2</sub> .
<b>Moreno Shale</b> (Well Correlation includes Ragged Valley Silt) <b>Secondary Confining Zone</b>	The Moreno shale is an organic rich marine shale. Because of the Moreno Shale's thickness (~1100ft) and because it is regionally extensive, it is intended to provide a seal to ultimately contain any injected CO <sub>2</sub> that may be migrating up from the below First Panoche sandstone.
<b>First Panoche Sandstone</b> <b>Secondary CO<sub>2</sub> Injection Zone</b> (Permission to inject into this formation is requested)	The First Panoche is intended to be a secondary injection zone to be used if the Second Panoche below is unsuitable for injection or if there is CO <sub>2</sub> migration which passes up through the below First Panoche Shale.
<b>First Panoche Shale</b> <b>Primary Confining Zone</b>	The First Panoche Shale is intended to be the primary confining zone that will vertically contain most or possibly all the injected CO <sub>2</sub> . Because it is relatively thin (127 feet) and because its lateral continuity is unproven, this formation is not being relied upon to contain all the injected CO <sub>2</sub> . Currently, this formation is interpreted to be continuous within the model domain.
<b>Second Panoche Sandstone</b> <b>Primary CO<sub>2</sub> Injection Formation</b> (Permission to inject into this formation is requested)	The Second Panoche sandstones are the primary target for CO <sub>2</sub> injection.
<b>Third Panoche</b> <b>Potential CO<sub>2</sub> Injection Formation</b> (Permission to inject into this formation is requested)	Although not the target of this project currently, this formation may have potential in the future for CO <sub>2</sub> injection. The lower permeability of this formation will likely make this a lower confining zone.
<b>Third Panoche Shale</b> <b>Lower Confining Formation</b>	The shales of the Third Panoche are intended to act as the lowermost confining zone.
<b>Fourth Panoche</b> <b>Potential CO<sub>2</sub> Injection Formation</b>	Although not the target of this project currently, this formation may have potential in the future for CO <sub>2</sub> Injection.

Table 1: Formation Description and Intended Use

Table 2: Summary of Inconsistencies Addressed

<b>Summary of Inconsistencies Addressed</b>		
<b>Section</b>	<b>EPA Inconsistency in Black Text</b>	<b>CES Clarification</b>
2 Regional Geology and Geologic Structure	“Core samples are available from 1 well (NAPA AVE A/1, about 3 mi to the east)...”	<i>NAPA AVE A/1 is approximately 8.3 miles to the east.</i>
4 Depth, Areal Extent, and Thickness of the Injection and Confining Zones	“The primary confining layer is the Moreno Shale,...”	<i>The primary confining layer is the First Panoche Shale, the Moreno is the secondary seal that will ultimately contain the CO<sub>2</sub>.</i>
5 Hydrologic and Hydrogeologic Information	“...and so the water well summary in that document does not agree with the application narrative (Section 5.1.1 of Attachment B)”	<i>A large search radius (2.5 miles) for water wells was used to better understand the local hydrogeology, groundwater flow directions and water use.</i>
6.1 Characteristics of Injection Zone Formation Water	“The table does not indicate which Panoche Sand the value represents, and the depth is shallower than the target formation at the Mendota site”	<i>This public data source did not specify which Panoche Sandstone the sample was taken from and this was the nearest data point available.</i>
6.1 Characteristics of Injection Zone Formation Water	“CES anticipates a salinity of about 25,000 mg/L at the Mendota site, although it is not stated what this is based on other than possibly a general increase in salinity moving westward.”	<i>With deeper Panoche sandstones to the west at Mendota, it is expected that the salinity will be higher. The higher salinities were calculated by using the resistivity logs of 5 wells near the Mendota site. This was discussed in Section 2.7.1.</i>
6.2 Mineral Composition of The Injection Zone	“However, Table 7 does not specify which Panoche sand layers the data represents.”	<i>Table 7 represents mineralogy data likely from the Fourth Panoche sand at B.B Co 1.</i>
10 Facies Changes in the Injection or Confining Zones	“The description of the lithology from the B.B. Co 1 well is at a depth corresponding to the Fourth Panoche Sand. Figure 5 in the application narrative, however, shows the Second Panoche Sand as the primary injection formation, with the Fourth Panoche Sand as an optional formation.”	<i>Ideally core data from the Second Panoche is desired; however, B.B. Co 1 core was only available for the Fourth Panoche.</i>
11 Structure of the Injection and Confining Zones	“Future cross sections should show an aerial view with transects labeled.”	<i>Final update of Narrative will include labeled transects.</i>
13 Confining Zone Integrity	“The current porosity and permeability estimates for the Moreno Shale are 8% porosity and 4.7 mD for permeability (Table 3). The porosity appears low and the permeability appears somewhat high for a shale.”	<i>These values may be higher than expected; however, this estimate lacks core data calibration in the Moreno Shale.</i>

## 1.1 Update to Regional Geology, Hydrogeology, and Local Structural Geology [40 CFR 146.82(a)(3)(vi)]

*The Mendota site is located in the central San Joaquin Basin in Fresno County, California. The San Joaquin Basin formed as a forearc basin between the subducting Farallon plate in the west and the Sierra Nevada volcanic arc to the east accumulating 25,000 ft of sediment overlying basement rocks capturing the last 100 million years of sedimentary and tectonic history. The San Joaquin Basin forms the southern half of California's Great Valley and is a major petroleum province.*

*The proposed Mendota\_INJ\_1 site is situated approximately 10 miles east of the late Cretaceous axis of the San Joaquin Basin, between Gill Ranch (GR), closer to the eastern edge of the basin, and Cheney Ranch (CR) gas fields, just west of the ancient basin axis, 6.5 miles NE and 11.7 miles SW of the projected well, respectively (Figure 1). Historical gas production at Gill Ranch targeted late Cretaceous sandstones in a low amplitude structural closure, <100 feet, bounded by faults interpreted as high angle reverse faults oriented NW-SE. Currently, the Gill Ranch field is being used for gas storage operations exploiting the properties of the reservoir sandstones. One inconsistency in the region is the depositional setting and naming convention of the sandstones at the Gill Ranch field and at the Mendota injection site. Mapping depositional settings in this basin is challenging because of the varying interpretations of stratigraphic classifications over time, changing sea level and to evolving tectonic settings from forearc margin to strike slip (Hosford Scheirer & Magoon, 2007).*

*Regional studies across the San Joaquin basin show a Cretaceous shelf edge subparallel to the NW-SE orientation of the basin axis just west of the Gill Ranch Field (Figure 1) (Hosford Scheirer & Magoon, 2007). West of the shelf edge margin is an interpreted slope with expected channel and fan deposits (Figure 2a). The position of the Gill Ranch field on the Cretaceous shelf suggests that its reservoir sandstones are deltaic and referred to in multiple publications as the Starkey sandstones; however, Panoche has also been used to describe the Cretaceous sandstones at Gill Ranch in published reports and in well records. Deltaic Starkey formations on the shelf edge prograde into channel and fan deposits downdip into the Lathrop sandstone and Forbes Formation, which have been described also within the Cretaceous Panoche Formation; the Starkey formation is coeval to these downdip formations on the slope. The reference to the shelf and slope sandstones as Panoche in multiple publications and well reports contributes to the confusion. This is partly due to the attempt to correlate the subsurface stratigraphy with the Panoche formation interpreted in outcrop. Based on Panoche as a naming convention for the slope and deltaic sandstones and as a late Cretaceous formation below the regional Moreno Shale, this terminology has been retained for characterization purposes. For correlation purposes, the Moreno shale includes the Ragged Valley Silt formation above the First Panoche sandstone.*

*In addition to the inconsistent naming convention, there is uncertainty with the depositional environment at the injection well. Figure 2b, Figure 2c and Figure 2d show three possible scenarios for the depositional environment expected at Mendota\_INJ\_1.*

- *Figure 2b (Likely Scenario) shows scenario where the Mendota\_INJ\_1 well is in channel and submarine fan deposits located on the slope of the basin with an up-dip stratigraphic pinch out into Moreno shales.*
- *Figure 2c (Modeled Scenario) shows a scenario where the Panoche Formation sandstones of different depositional environments (Figure 2b, and Figure 2d) are connected. Because of the correlation in well logs across the model domain, a conservative approach was taken to connect these sandstones for reservoir characterization and reservoir simulation purposes.*
- *Figure 2d (Less Likely Scenario) is less likely scenario, but within the mapping uncertainty, where*

*the Mendota\_INJ\_1 well intersects the distal deltaic shelf deposits.*

*If Mendota\_INJ\_1 is in the submarine fan sandstones (Figure 2b), then there is a much greater chance of an up-dip stratigraphic pinch out into Moreno shales, providing an additional lateral seal for injected CO<sub>2</sub> to the northeast. These sandstones may still have some connection up-dip through sand-filled channels to the deltaics. Because of these depositional uncertainties and to take a conservative approach to AoR estimation, the geomodel used in site characterization and dynamic modeling considered connected sandstones (Figure 2c). The compartmentalization of the reservoir sandstones can be stratigraphic but also structural. Near the proposed Mendota site, there are two known faults (USGS, 2019) located approximately 5 miles away, but there are no other major geological features defined. Faults are best interpreted from seismic data. The limited 2D seismic data across the study area shows minor structural deformation but any incoherency in the data was interpreted as a possible fault. This interpretation has a high degree of uncertainty because of the vintage of the data but the lack of clear fault offset suggests that large throw faults are not common.*

*Figure 3 is a site-specific stratigraphic column at Mendota\_INJ\_1 which describes the lithology of the Late Cretaceous Moreno Formation, which is underlain by the Panoche Formation. The Panoche Formation is separated into specific sandstone intervals separated by shale layers and labelled First, Second, Third and Fourth Panoche from youngest to oldest. Injection and confinement zones for the Mendota\_INJ\_1 well include the Cretaceous First and Second Panoche sandstones and their overlying shale formations separating the sandstones at 8000-12000 ft below ground surface (bgs), with the overlying Moreno shale at 7000-8000 ft bgs providing regional confinement.*

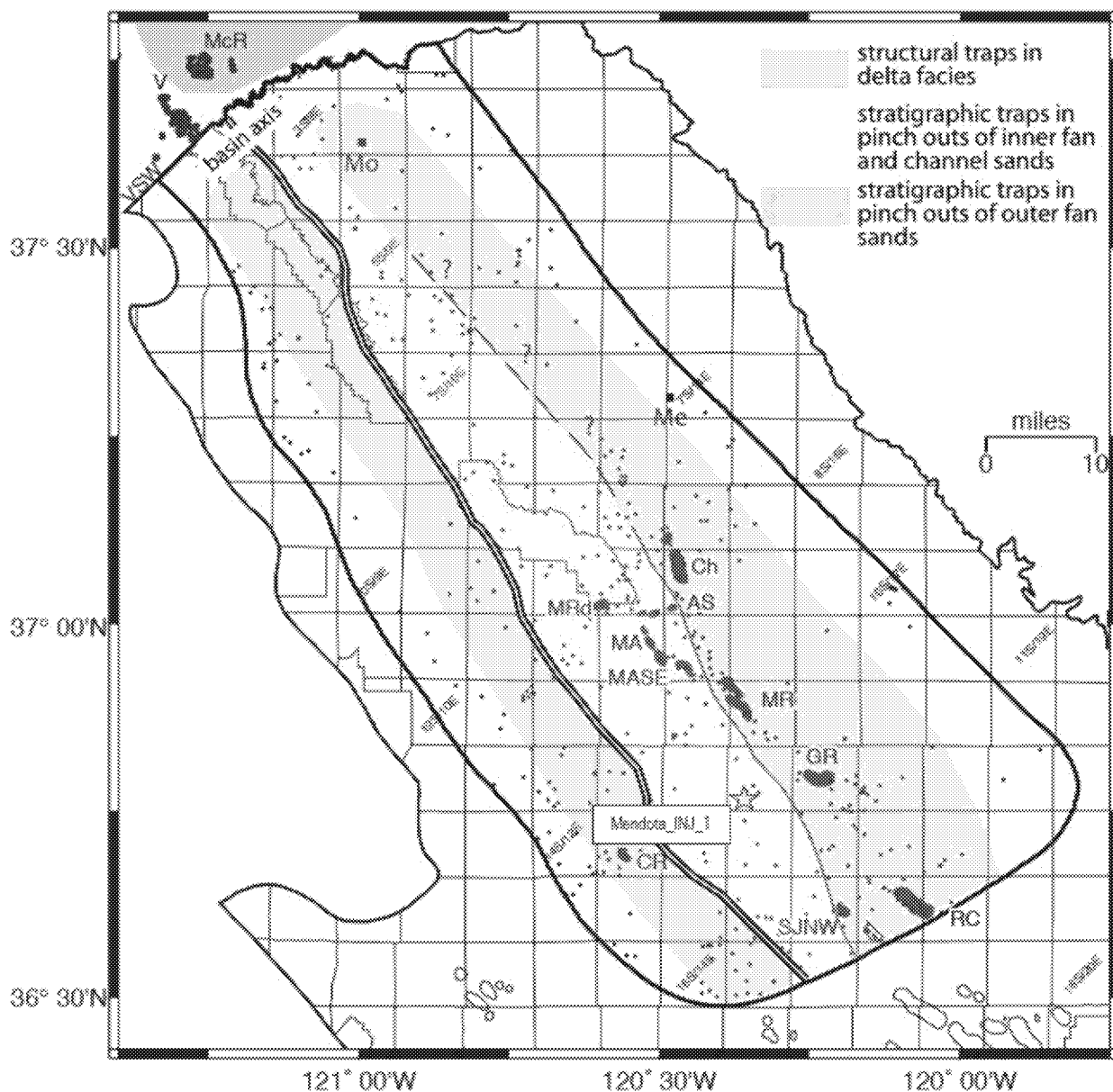


Figure 1: San Joaquin basin depositional model showing structural and stratigraphic traps; The yellow star indicated the proposed Mendota\_INJ\_1 location. (Hosford Scheirer & Magoon, 2007)

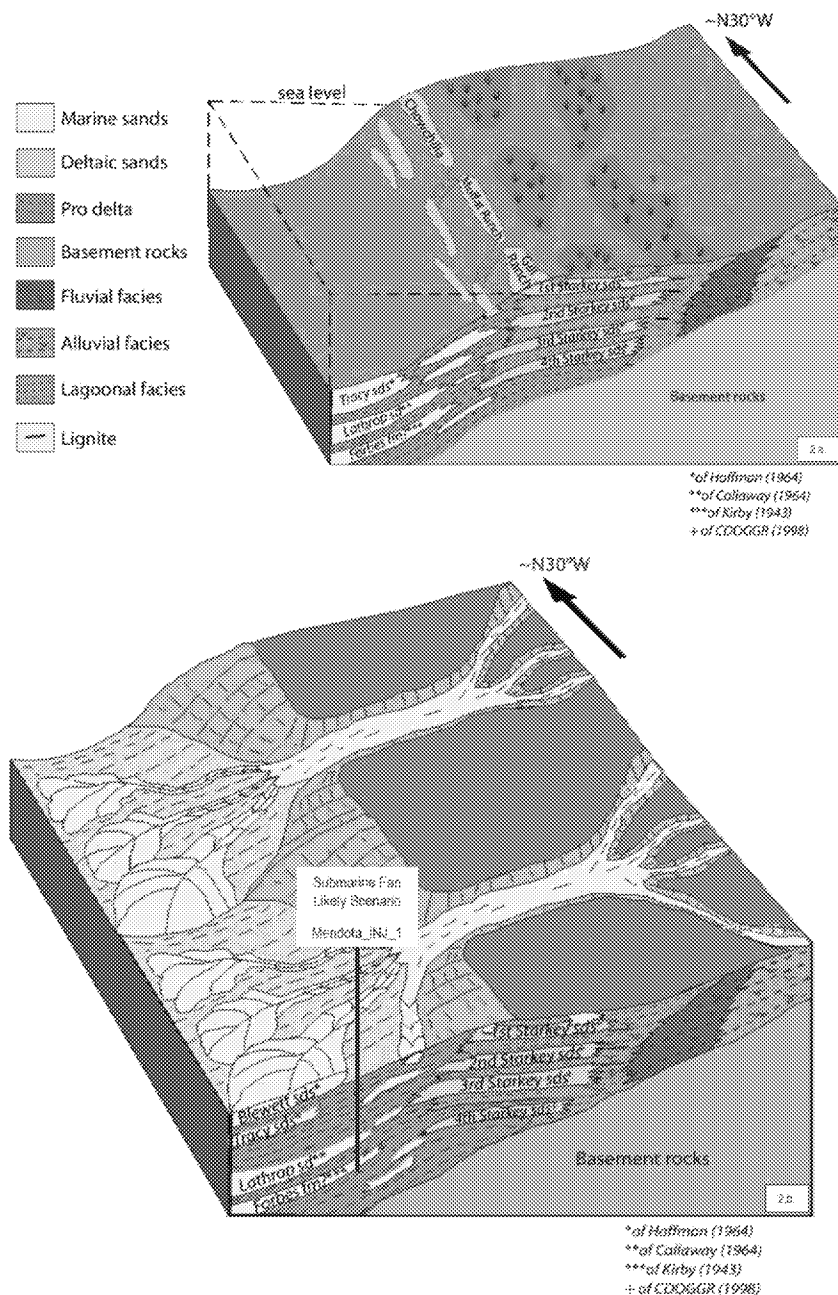


Figure 2a and 2b: San Joaquin basin depositional model showing three possible depositional scenarios for the location of Mendota\_INJ\_1. Modified from (Hosford Scheirer & Magoon, 2007)

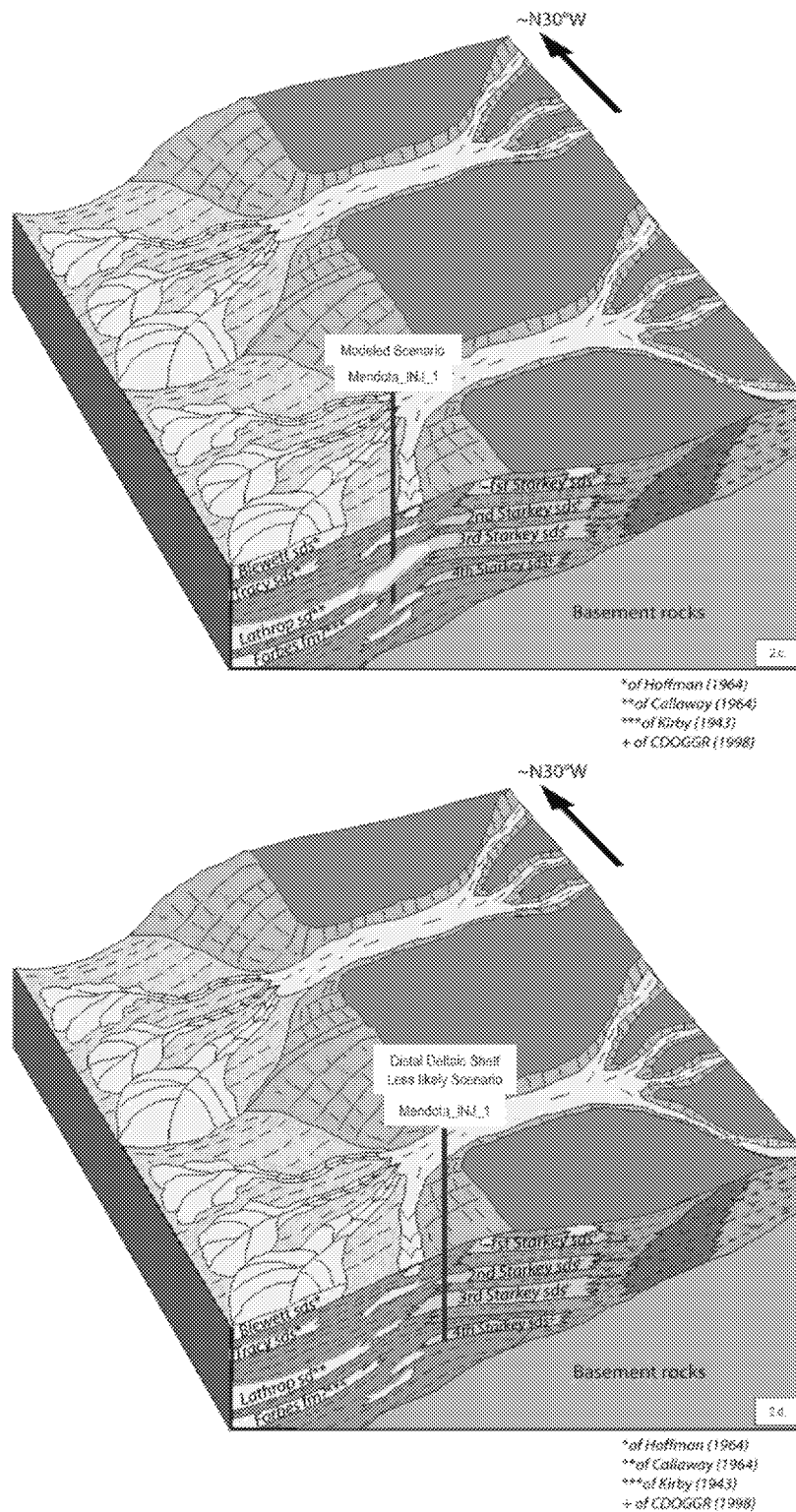


Figure 2c and 2d: San Joaquin basin depositional model showing three possible depositional scenarios for the location of Mendota\_INJ\_1. Modified from (Hosford Scheirer & Magoon, 2007)

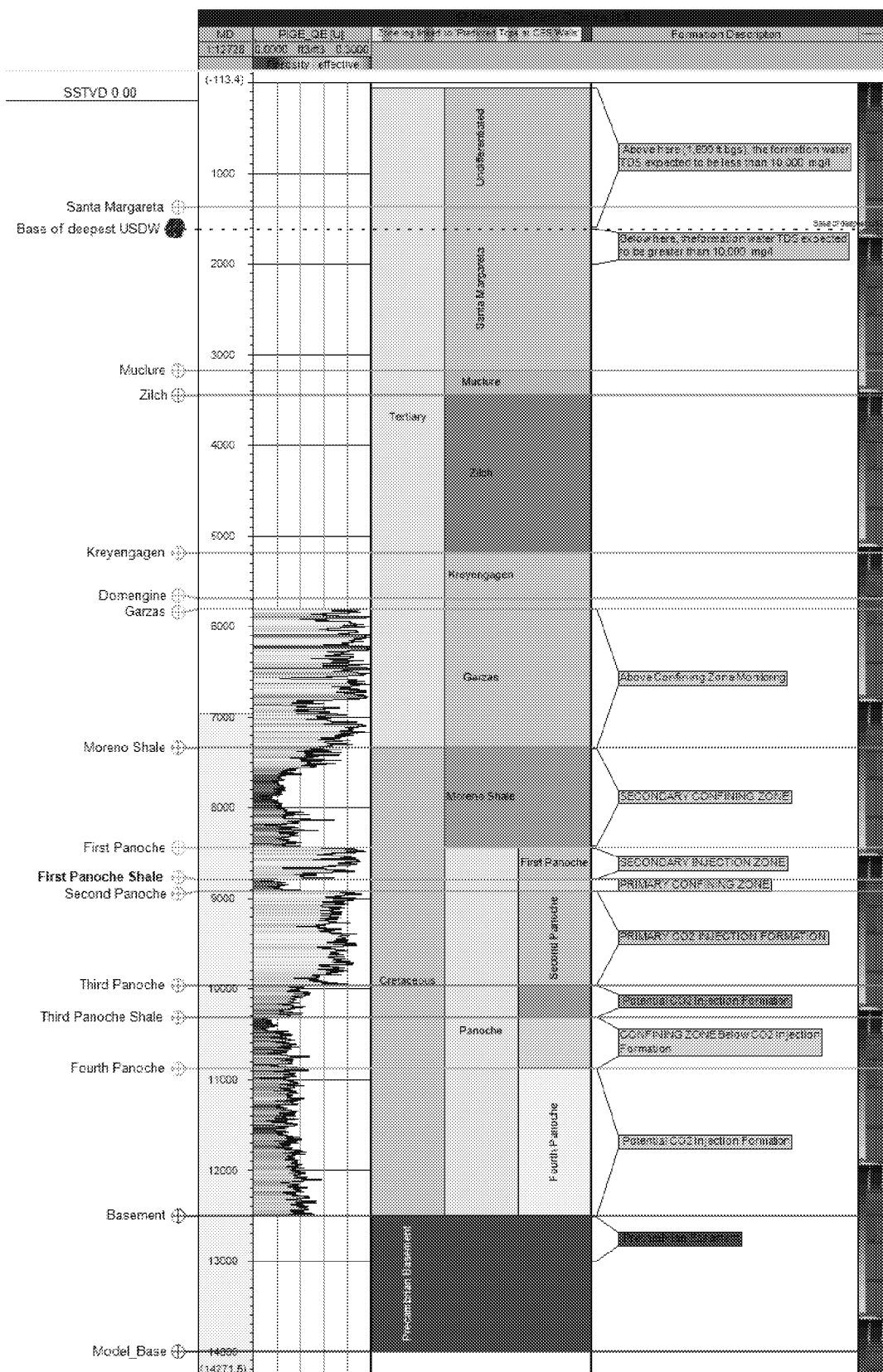


Figure 3: Stratigraphy column. Schlumberger Petrel\* 2020.

## ENCLOSURE

### Site Characterization Evaluation of the CES-Mendota Class VI Permit Application

This site characterization evaluation report for the proposed CES-Mendota geologic sequestration project summarizes the geologic evaluation and data submitted by CES in the Class VI UIC permit application narrative per 40 CFR 146.82(a) and 146.83. It describes and evaluates the available data on which the permit application for Well Mendota\_INJ\_1 (the proposed injection well) is based and identifies uncertainties that CES will be required to address with pre-operational testing at the Mendota site before CES will receive an authorization to inject CO<sub>2</sub>. This evaluation also identifies additional information or clarification needed for EPA's continued evaluation of the permit application.

## 2 Regional Geology and Geologic Structure

The Mendota site is located within the central San Joaquin Basin, situated along the basin's deepest axis. The basin contains 25,000 feet of sediment, spanning various changes in sea levels and tectonic settings. The San Joaquin Basin trends NW-SE and is aligned with the Sierra Nevada at its eastern edge. The proposed injection zone, the Cretaceous age First and Second Panoche Sands of the Panoche Formation, and confining layer, the Moreno Shale, pinch out against the Sierra Nevada basement rocks to the east. In addition to the Moreno Shale, laterally heterogeneous turbidite deposits form interbedded shales that act as stratigraphic traps within the Panoche Formation (page 15). The central San Joaquin Basin is shown in depositional model in Figure 3 and cross section in Figure 4 (page 16) and stratigraphic column in Figure 5 (page 17). In this part of the basin, the subsurface dip is approximately 4 degrees to the SW (page 18). CES delineated a pressure-based area of review (AoR) that extends over a 2.2 square miles surface area to the northeast of the proposed injection well (it is all within a 2-mile radius to the northeast).

The permit application is based on log data from 10 wells to the north, east, and south of the proposed injection well. Resistivity logs were run in all 10 wells; most also have spontaneous potential (SP) or compressional slowness (from acoustical logs) or both; 3 have gamma ray, bulk density, and neutron porosity logs. Core samples are available from 1 well (NAPA AVE A/1, about 3 mi to the east). While there are no well data to the west of the proposed injection well, CES acquired 2D seismic data for areas to the west.

## 3 Faults and Fractures

To evaluate the faults and fractures in the region and in the AoR, CES gathered faulting data from public sources and interpreted them locally across three 2D seismic lines (Figures 16-18). These seismic lines are shown in three dimensions in Figure 19 (page 31). Most of the faults in the area are small throw features, with a few exceptions. Faults 1 and 2 trend north and separate the Mendota AoR from the Gill Ranch Field to the east. These are shown in the seismic line in Figure 16. The location of Fault 1 is indistinct, and more information is needed for accurate positioning (page 26). Faults 3 and 4 are located nearer to the proposed injection well and have small normal displacement, but do not appear to extend above the Third Panoche Formation. Fault 13 dips approximately 30 degrees SE and passes below the Mendota\_INJ\_1 well injection target at a depth of 9,850 TVDSS. The exact nature of this feature is unknown, but because its dip orientation is perpendicular to the regional principal stress direction of ~N45E, CES interprets the fault as strike-slip or due to wrenching or differential settlement in the basin (page 26).

A fault seal analysis was conducted on Fault 13 using a geocellular model. Based on this analysis, CES concluded that sediment displacement across the fault is likely low, and that injected fluid will therefore be confined to the Second Panoche Sands injection zone. If sediment displacement is high, injected fluids may migrate but would be limited to zones below the Moreno Shale because the clay from the Moreno would smear along the fault during displacement (pages 26-27). The clay content, based on Fault Clay Prediction, is shown in Figure 22 (page 33). At this time, no hydrocarbons have been identified in exploration wells to determine whether the fault is sealing. Furthermore, CO<sub>2</sub> plume simulations show the plume migrating to the northeast, away from Fault 13 (page 27).

### 3.1 Questions/Requests for CES:

- *What are the blue lines that trend NW-SE in Figure 14? Do these represent faults, and if so, which ones?*
  - *The blue polygons trending NW-SE in Figure 14 do represent surface faulting identified by the USGS (<https://mrdata.usgs.gov/geology/state/map-us.html>). The subsurface locations and names of these faults are currently unknown. Field pool data from Gill Ranch estimates the western fault dips east and the eastern most fault is near vertical.*
- *The text on Figures 16-19 is difficult to read. In particular, it is not possible to identify Faults 1, 2, 3, 4, and 13 on Figure 19. Are higher resolution figures available?*
  - *The images in Figures 16-19 were captured at a higher resolution, with additional labeling of key faults and reformatted from portrait to landscape. Please refer to Appendix A: Updated Figures.*
- *On page 15, the application states that there are two known faults near the Mendota site. To which two faults does this refer?*
  - *The two faults referenced on page 15 are the same two faults within the Gill Ranch field discussed in the first question above. The USGS does not explicitly name these faults.*
- *What is the extent of the planned 3D seismic survey?*
  - *The extent of the planned 3D seismic survey is designed to contain full fold and maximized azimuth distribution over the modeled area of the plume after 20 years of injection. The fold and azimuthal distribution will taper away from the plume edge.*

### 3.2 Objectives for Pre-Operational Testing:

- *Determine the position of Fault 1 via 3D seismic data.*
  - *3D seismic will be acquired to better define the geometry of all faults within the plume area.*
- *Determine the nature of the displacement of Fault 13.*
  - *By combining the 3D seismic data interpretation with a geomechanical model calibrated to core and well test data, the dynamic mechanical stability and displacement along the fault can be determined either through analytical or numerical stress analysis. Since there is uncertainty associated with the current location of the faults interpreted on the 2D seismic lines - (especially Fault 13, which is interpreted on the E-W seismic lines, but not evident on the seismic line closest to the well), the 3D seismic interpretation will improve the position and relative displacement of the faults.*

- *Collect core data to demonstrate the sealing capacity of Fault 13.*
  - *Core data will be collected from the monitor and injection well locations.*
  - *The location of Fault 13 is uncertain and possibly may not even exist (because of the nature of interpreting on 2D seismic and the distance between the 2D seismic lines). Also, the injection well as currently planned, stops several hundred feet above the interpreted fault therefore the well does not intersect the interpretation for Fault 13. Since the injection well stops above the interpreted Fault 13 no core data can be collected across Fault 13's location. The core analysis results will validate the geomechanical model which will facilitate a more reliable assessment of the fault stability.*
- *Perform 3D geomechanical modeling based on data collected via well logs, geomechanical core analysis, and well testing, combined with 3D seismic data to better characterize the faults in the area and determine their sealing capacity and that they are non-transmissive.*
  - *3D seismic will be acquired to enhance the fault geometry throughout the area. The same methodology referred to above in determining the displacement of Fault 13 will be applied to the faults in the survey area. The improved interpretation of the fault and horizon data and the integration of the well data will better constrain the analysis of any cross-fault transmissivity and associated risks.*

## 4 Depth, Areal Extent, and Thickness of the Injection and Confining Zones

The Panoche Formation is regionally located at 8,000-12,000 feet below ground surface (bgs). Based on the stratigraphic column (Figure 5), the Second Panoche Sands (the primary injection zone) is approximately 8,900-10,000 ft bgs. A second, potential injection zone is the Fourth Panoche, located from about 10,900-12,500 ft bgs. These intervals are also shown on the cross section in Figure 6. Section 2.2 of the application narrative states that the proposed injection targets are the First and Second Panoche Sands, whose tops are estimated at depths of 8,437 and 8,918 ft bgs, respectively. Formation surface maps (Figure 12) and isochore maps (Figure 13) show that all units are laterally continuous across the region. According to the isochore maps in Figure 13, the First Panoche ranges in thickness from about 275 to 750 ft across the 5-mile radius from the Mendota site, the Second Panoche ranges from 780 to 1,170 ft, and the Fourth Panoche ranges from 1,400 to 2,500 ft.

The primary confining layer is the Moreno Shale, which is regionally located directly above the Panoche Formation at 7,000-8,000 ft bgs. On the stratigraphic column in Figure 5, the Moreno Shale is located at 7,350-8,450 ft bgs (page 17). According to the isochore map in Figure 13, the Moreno Shale ranges in thickness from about 500 to 1,650 ft across the 5-mile radius from the Mendota site.

Secondary stratigraphic seals are provided by shales within the Panoche Formation. According to Figure 5, the First Panoche Shale is from 8,800-9,000 ft bgs, and the Third Panoche Shale is from 10,300-10,900 ft bgs. According to the isochore maps in Figure 13 (page 25), the First Panoche Shale ranges in thickness from about 60 to 190 ft across the 5-mile radius from the Mendota site, and the Third Panoche Shale ranges from about 200 to 1,100 ft.

The north-south trending cross sections are corroborated by the 2D seismic data, in terms of dip and approximate formation depths. The images based on seismic data do not show the separate shale layers within the Panoche Formation, whereas the cross-section does. This will be confirmed via pre-operational testing and the planned 3D seismic survey.

The table below summarizes the depth and thickness of the formations of interest.

Unit	Depth	Approximate thickness across AoR (Figure 13 isochore maps)
Moreno Shale	7,332 ft bgs (Narrative pg 18)	500-1,650 ft
First Panoche	8,437 ft bgs (Narrative pg 18)	275-750 ft
First Panoche Shale	8,800 ft bgs (Figure 5)	60-190 ft
Second Panoche	8,918 ft bgs (Narrative pg 18)	780-1,170 ft
Third Panoche	9,950 ft bgs (Figure 5)	150-750 ft
Third Panoche Shale	10,300 ft bgs (Figure 5)	200-1,100 ft
Fourth Panoche	10,900 ft bgs (Figure 5)	1,400-2,500 ft

#### 4.1 Objectives for Pre-Operational Testing:

- *Confirm thicknesses and depths of the injection and confining zones at the Mendota site through seismic imaging and information gained during drilling of the proposed injection well and deep monitoring well.*
- *The thicknesses and depths of the injection and confining zones at the Mendota site will be confirmed with the use of 3D seismic and data gathered while drilling the injection and monitoring well.*

## 5 Hydrologic and Hydrogeologic Information

The lowermost underground source of drinking water (USDW) is an unnamed interval within the Santa Margarita Formation that is estimated to be present around 1,600 ft bgs (page 18), or 1,415 ft TVDSS (page 57); this is located 7,165 feet above the top of the Second Panoche Sands (page 59). The total dissolved solids (TDS) content was determined by applying Archie's equation to the resistivity logs of 5 wells to the north and south of the Mendota site to determine TDS values. CES states that calculated salinity indicates that the base of the USDW is between 1,200 to 1,450 feet TVDSS. Uncertainties in this estimate include formation porosity, Archie equation parameters (standard parameters were used for now), and the effects of clay (page 57).

According to field data sheets for wells located in nearby oil and gas fields, the Jergins Formation at Cheney Ranch and the Blewett Formation at Merrill Ave have salinities of 8,500 and 15,000 mg/L, respectively. The Jergins and Blewett Formations are in the Moreno Shale. Salinities of these sands at the Mendota site will need to be confirmed via sampling and analysis during drilling of the characterization well.

CES retrieved shallow groundwater well information from the California Department of Water Resources. There are 525 active and non-active water wells within a 5-mile radius of Mendota\_INJ\_1, in all directions from the proposed site. Accurate locations of these wells are not known at this time. The wells range in depth from 50 to 500 feet. Their water levels, which were recorded at the time of drilling, were used to estimate groundwater elevation and flow direction. At the Mendota site, the shallowest groundwater is around 32 feet bgs (114 ft TVDSS). The San Joaquin River flows north-south and is 0.6 miles east of the site. For the AoR and Corrective Action Plan in Attachment B, CES used a fixed well search radius of 2.5 miles in order to account for uncertainty in the model, and so the water well summary in that document does not agree with the application narrative (Section 5.1.1 of Attachment B).

## 5.1 Questions/Requests for CES:

- *The application states that the base of the lowermost USDW is estimated between 1,200 to 1,450 feet TVDSS, while the depth to the USDW is estimated at 1,415 TVDSS. Please clarify the discrepancy.*
- *The lowermost USDW is estimated between 1,200 to 1,415 feet TVDSS. The estimation is based upon log calculations thus there is some uncertainty which will be resolved when data becomes available from the drilling of a well.*
- *Please provide a legend or labeled contours for the potentiometric map in Figure 47.*
- *Figure 47: Potentiometric map of the approximate shallowest groundwater surface was updated with labeled contours. Please refer to Appendix A.*
- *What is the vertical distance between the First Panoche Sands and the lowermost USDW?*
- *At the proposed injection well location, Mendota\_INJ\_1, the vertical distance from the First Panoche Sandstone to the calculated lowermost USDW (1,415 TVDSS) (10,000 TDS) is 7,018 ft. This clarification was added to Figure 46. Please refer to Appendix A: Updated Figures.*
- *Figure 46 includes a line marking the base of fresh water at 10,000 TDS. Section 2.7.1 of the application narrative discusses a BFW of 3,000 mg/L. Please confirm that no evaluations of the lowermost USDW are based on a definition of 3,000 mg/L.*
- *The lowermost USDW in this application always refers to the 10,000 TDS limit. The California regulations of 3,000 mg/l (base of fresh water) was used as a quality control check when reviewing well reports.*
- *Figure 45 also appears to demarcate the BFW and the USDW based on salinity, but the resolution of the figure is too low to read the legend. Please provide a higher resolution version of Figure 45.*
- *Figure 45 has been incorporated with higher resolution. Please refer to Appendix A: Updated Figures.*

## 5.2 Objectives for Pre-Operational Testing:

- *Sample formation water collected during drilling of the injection and monitoring wells to determine the base of the lowermost USDW and confirm that available resistivity logs and data from nearby fields is representative of the Mendota site.*
- *Formation water samples will be collected (when water is present) during the drilling of the injection and monitor wells. The newly acquired resistivity log data will be compared to the other well data available in the area.*
- *Verify the salinities for the permeable Jergins and Blewett formations within the Moreno Shale at the Mendota site to confirm that none are USDWs.*

- *Water samples will be collected within the Jergins and Blewitt formations (when water is present) and analyzed to confirm whether the formations are USDWs.*

## 6 Geochemistry

### 6.1 Characteristics of Injection Zone Formation Water

There was no available formation water information in the Panoche Formation at the Mendota site. Available formation water information from nearby oil and gas fields shows that TDS is 20,900 mg/L in the Panoche Formation at Gill Ranch, and 14,000 mg/L in the Moreno Shale at Cheney Ranch (Table 6).

There appears to be only one data point in the table for the Panoche Formation, at Gill Ranch, which is approximately 6.5 miles to the northeast of Mendota. The table does not indicate which Panoche Sand the value represents, and the depth is shallower than the target formation at the Mendota site. The text states, however, that there are wells at Gill Ranch that penetrate through the Fourth Panoche Sand. CES anticipates a salinity of about 25,000 mg/L at the Mendota site, although it is not stated what this is based on other than possibly a general increase in salinity moving westward.

CES states that logs from wells in the AoR do not indicate that any sand unit has formation water fresher than the Panoche Formation and acknowledges that this is an area of uncertainty. CES also states that formation water sampling for the Panoche Formation and overlying sands is included in the proposed testing plan in Attachment G. The plan indicates fluid testing for geochemistry in both the proposed injection well and observation well. Table 10 of the Testing and Monitoring Plan identifies analytical and field parameters for fluid sampling in the injection zone. It includes TDS along with a suite of other parameters.

#### 6.1.1 Questions/Requests for CES:

- *Were any of the data values in Table 6 based on fluid sampling or well logs? If so, how many data points do the values represent?*
- *The aqueous chemistry data in the report (Conservation, 1998) are actual fluid samples. CES assumes these were collected under standard operating procedures in line with state reporting requirements. The report does not provide the sampling methods, but they are typically obtained and separated at the wellhead. The report does not specify the number of samples or from which wells the samples were taken for each formation, nor the actual depths of the samples. It is assumed the values represent averages from a specific formation from several wells.*
- *The data point from Gill Ranch is 6.5 miles away and represents a depth shallower than the Mendota injection zone. Cheney Ranch is approximately 12 miles southwest of the Mendota site. Please provide information to demonstrate the degree to which data from these fields are representative of the Mendota site.*
- *Formation water from the Gill Ranch field is likely similar to that of the Mendota site as they may share the same initial pore water (sea water) during deposition and similar porewater evolution; however, the lateral continuity of the sandstones between these sites is uncertain and they may have discontinuous hydrologic systems. The sandstones at Gill Ranch are located up dip and could be deltaic whereas those near the injection location are expected to be turbidites on slope. There is a greater possibility of meteoric water infiltration into the sandstones up dip and dilute the pore water during the burial history, which indicates higher salinity in the*

*injection zone. Since the Cheney Ranch field targets sandstone above the Panoche formation in the Moreno formation (Jergins sandstone), it is uncertain whether the data points from this field are representative of the Panoche formation at the proposed Mendota\_INJ\_1 site. Fluid samples from the injection zone are required to confirm the formulation fluid chemistry.*

### 6.1.2 Objectives for Pre-Operational Testing:

- *Confirm the TDS values in the sand units within the Panoche Formation and in the Moreno Shale.*
- *If recoverable formation water is present, samples will be collected and analyzed. As part of the water analysis the TDS will be calculated.*
- *Obtain a complete water analysis in the injection zone to provide inputs to support the geochemical modeling and determine whether available data from nearby fields is representative of the Mendota site. The analytical parameters should match/provide a baseline for future testing and monitoring.*
- *The planned water analysis will include the below analytical parameters; these results will provide a baseline to be used for future testing and monitoring which will confirm whether the available data from nearby fields are representative.*
  - *pH*
  - *Specific gravity*
  - *Resistivity/Conductivity*
  - *TDS (Total Dissolved Solids)*
  - *Turbidity*
  - *Total Hardness*
  - *Inductive Coupled Plasma (ICP) for cations*
  - *High Pressure Ion Chromatography for anions*
  - *Dissolved gases (H<sub>2</sub>S, CO<sub>2</sub>, O<sub>2</sub>, etc)*

## 6.2 Mineral Composition of The Injection Zone

Mineralogic information for the injection zone comes from the Fourth Panoche Sand at the B.B. Co 1 well, which is in the AoR (within 2.5 miles northeast of the proposed injection well). The estimated mineral composition for the Panoche Formation described in Table 7 is proposed for geochemical modeling. However, Table 7 does not specify which Panoche sand layers the data represents. Data specific to the targeted injection zone (i.e., the First and Second Panoche Sands) at the Mendota site will be needed.

*Table 7: Estimated mineral composition (wt. %) for the Panoche Formation used in geochemical modeling*

Quartz	K-feldspar	Plagioclase	Calcite	Pyrite	Muscovite	Chlorite	Illite	Kaolinite
60	10	15	4.5	0.5	2	2	6	Trace

The testing plan in Attachment G describes planned core analysis by x-ray diffraction for core samples in both the proposed injection well and deep monitoring well.

**6.2.1 Questions/Requests for CES:**

- *How many core samples are proposed to be analyzed and from what depths?*
  - *A combination of whole core and mechanical sidewall plugs will be taken from the well to ensure the best coverage for characterizing the formations. Whole core will be taken over sections of the Moreno Shale, First Panoche Sandstone, First Panoche Shale, Second Panoche Sandstone and Third Panoche. Mechanical Sidewall plugs will be taken over specific points not covered by whole core and on any other areas of interest identified from logs and drilling. Current estimates of whole core footage will be in the several hundred feet range and in the tens of plugs taken from the mechanical sidewall tool. Footages of whole core and number of plugs from mechanical sidewall may increase or decrease due to core acquisition and drilling information. An HRA (Heterogenous Rock Analysis) provides a mathematically precise methodology (derived from Triple Combo Logs) for rock typing and will assist in determining the number of samples to be taken that for each rock type identified in the well.*
  - *Cuttings will be used to provide mineralogy from overlying and underlying formations. Sample spacing would be in the range of 20 to 30ft.*
- *Does CES propose to perform other analyses of core samples besides XRD to document the mineralogy of the injection zone (e.g., polarized light microscopy)?*
  - *As noted, the XRD analysis will provide an averaged mineralogy per sampled depth interval.*
  - *Other recommended core analyses that will be used include:*
    - *XRF (using FIT/FIS technique), on cuttings along the entire zones of interest.*
    - *DRIFTS (using FIT/FIS technique), on cuttings along the entire zones of interest.*
    - *XRD on a subset of the XRF samples, as well as on samples from the collected whole core and rotary core samples.*
    - *Thin section analysis at the same locations where XRD was conducted.*
    - *SEM-EDX on a subset of the XRD samples as determined by thin section analysis.*

**6.2.2 Objectives for Pre-Operational Testing:**

- *Obtain a mineralogic analysis of the injection zone and confining zone solids that represents the Mendota site.*
- *Please refer to above reply on the recommended core analysis.*

## 7 Geomechanical and Petrophysical Characterization

Petrophysical properties of the injection and confining zones were estimated using the well log data from 10 wells to the north, east, and south (primarily to the east) of the proposed injection well drilled between 1942 and 1987 (Table 2); the data were analyzed using Techlog software. Only two of the wells listed in Table 2 are within the 5-mile radius as shown in Figure 8--these are B.B. Company /1 (2.32 miles to the

northeast) and Sterling-Coleman/1 (about 4 miles to the southeast).

The well log data were upscaled and used as the basis for populating properties throughout a geomodel, which ultimately supports numerical modeling of the Mendota site.

On page 34, CES states that “The petrophysical workflow involved building a model using well log data from NAPA AVE A/1 calibrated to core data for the same well (TGS, 2019).” The NAPA AVE A/1 well is 3 miles east of the site.

## 7.1 Questions/Requests for CES:

- *Given that the available porosity and permeability values are based on logs from 10 wells of different ages and spread over several miles, what information is available to demonstrate that these are comparable and representative of the Panoche Formation within the AoR?*
- *Although the wells are spread over several miles they are located in a Cretaceous depositional setting based on regional mapping and published interpretation (Hosford Scheirer & Magoon, Petroleum Systems and Geologic Assessment of Oil and Gas in the San Joaquin Basin Province, California, 2007) across a deltaic shelf sequence that grades across the slope into a channel fan sequence with the shelf edge trending NW-SE. The First Panoche Shale above the Second Panoche Sandstone is a regionally extensive sequence boundary within this depositional sequence that has been correlated with a high degree of confidence across the 10 wells. The well nearest to the AoR that reaches the Panoche formation is B.B COMPANY/1 (2 miles NE of Mendota\_INJ\_1). Digital log responses from B.B COMPANY/1 show sandstones that correlate across the 10 petrophysical wells below and above the First Panoche shale. These sandstones are interpreted as either part of the distal deltaic sandstones or the channel fan sequence on the slope. CES expects that within these sequences there may be some minor differences in mineralogy, grain size and porosity, but that, in general the properties will be similar. The small difference in depth to the reservoir sandstones between the closest well, B.B COMPANY/1, and the proposed injection well regardless of whether the sandstones are in physical communication suggests also that the petrophysical properties are likely comparable to Panoche sandstones modeled in the AoR.*
- *What method(s) was/were used to calibrate the well log data to the core data?*
- *The primary method used to calibrate the petrophysical model to the cored data is taking the core variables and overlaying it on top of the corresponding well log or processed log variables for comparison and making model adjustments as needed. In addition to performing a direct comparison, the data was also plotted as trend vs depth (increase permeability/porosity, changing clay volume with depth). These comparisons provide insight on how the well variables align with the core data. Adjustments were made to hone the model to improve the relationship between core and well/processed logs. In the model, endpoints of the minerals were altered, constraints on volume of minerals, and other adjustments were made in the porosity / permeability relationship to enhance the correlation.*
- *What is the error/variability associated with these methods?*
- *Variabilities can exist with both core and log data due to the age of the information, existing technology when data was acquired, experience and quality of the service company, handler/logger errors, differences in resolution of the data, and digitization of paper logs. These variabilities are within the standard level of uncertainty and are addressed in the core to*

well calibration.

- Will the same method(s) be used to calibrate the core data to the well log data at the Mendota site?
  - In principal, the methods will be the same with comparing the core and well log data; however, at the Mendota site, additional cores and well logs will be acquired. With modern core processes and the latest logging technology, it will be possible to compare not only porosity and permeability but also mineral weights and volumes, geomechanical stresses, geochemistry, and total and effective porosity and saturations. With modern core processes and the latest logging technology, it will be possible to compare not only porosity and permeability but also mineral weights and volumes, geomechanical stresses, geochemistry, and total and effective porosity and saturations. Zone to zone adjustments will be required in the model to account for changes in the formation that are observed in the acquired core. The calibration from log to core is not made for the simple fact that the log variables must match the core variables. Physics of the inputs need to be real and not forced, meaning the model inputs must agree with each other and make sense. The calibration of the petrophysical models' outputs to the processed core variables requires an in-depth knowledge of the core measurements taken and how they align to the well log data. Modern core analyses and logs will enable for a more accurate calibration between the two.
- What is the spatial resolution of the log measurements?
  - The vertical resolution of log data is 0.5 ft intervals. Well logs were upscaled into the geomodeled cells at 4 ft vertical resolution. Lateral resolution of geomodel cells is 500ft x 500ft in the X and Y direction.

## 7.2 Objectives for Pre-Operational Testing:

- Gather site-specific measurements during drilling of the proposed injection well and deep monitoring well of capillary pressure, and information on fractures, stress, ductility, rock strength, elastic properties, and in situ fluid pressures within the confining zone to support an evaluation of confining zone integrity.

CES has the following plans for core analyses:

- Mercury injection capillary pressure
- Fracture analysis/description of the whole core
- Triaxial compression testing (with added stress stages and ultrasonic velocity measurements), of injection zones to measure static and dynamic elastic moduli and to calculate a mohr-coulomb failure envelope.
- Multi-stage triaxial compression testing on oriented samples (vertical, horizontal and 45deg), of seal zones in order to calculate anisotropic geomechanical properties.
- FIT/FIS analysis on cuttings for entire well bore on all wells in vicinity to determine pre-existing communication vertically and laterally.

### **Porosity**

The average Panoche Formation porosity estimates range from 20% in the First Panoche Sand to 10% in the Fourth Panoche Sand (Table 3). Average estimated porosity in the primary injection zone, the Second Panoche Sand, is 18% (page 39). The Moreno Shale is estimated to have an average porosity of 8%.

Total porosity of the injection zone was determined from bulk density or compressional slowness (run in 5

wells to the east and southeast of the proposed injection well). The clay volume (VCL), estimated from spontaneous potential or gamma ray logs (run in 10 wells), and irreducible water were then used to estimate effective porosity; the water associated with clay minerals and irreducible water must be removed from the total porosity to estimate effective porosity. CES acknowledges that there is uncertainty in the estimated effective porosity because an empirical relationship was used to estimate irreducible water.

### 7.3 Questions/Requests for CES:

- *What is the empirical relationship that was used to estimate irreducible water? How much uncertainty does this relationship entail?*
  - *The empirical relationship of 20% for sandstones and 30% in shales was used as a reasonable cutoff in the model to estimate irreducible water. Irreducible water is calculated from porosity and permeability and therefore is subject to the same level of uncertainty as the porosity and permeability calculations. Further acquisition of logs and core will increase the accuracy of porosity and permeability estimates which will decrease the amount of uncertainty regarding irreducible water.*
- *For the VCL estimates, Table 4: (Mineralogy summary from core XRD – NAPA AVE A 1; page 39) shows 10-22% potassium feldspar in the samples. Will that percentage of alkali feldspar bias the VCL values from gamma ray logs? Also, what units/depth/ were used as the reference points for clean sand and shale for the VCL estimates?*
  - *To mitigate the effect of alkali feldspar bias multiple log inputs were used to calibrate VCL. Due to the availability of digital log data SP was the primary input, calibrated to both Gamma Ray and Neutron Density. Core data was used to calibrate further in the sandstones and shales.*
  - *CES plans to perform XRD analysis on either the whole or rotary core to provide clay and K-feldspar content that can be used to calibrate the VCL estimation.*
- *The application narrative states, on page 34, that VCL log values greater than 30% were considered to be shale and anything less than 30% VCL was flagged as sand. What is the basis for this interpretation?*
  - *A cutoff of 30% is a reasonable reference point based on VCL log estimates to analyze reservoir vs. non-reservoir thicknesses and perform preliminary fault seal analysis. Site characterization data will enable a more sophisticated facies log calculation, such as HRA (Heterogeneous Rock Analysis) facies assignment.*
- *How many analyses for porosity are proposed to be performed with cores from drilling of the proposed injection well and observation well?*
  - *Two different porosity analyses are recommended to be performed on the core samples:*
    - *Basic Boyles Law helium porosity measurements within the injection zone whole core/rotary core samples, every 2-3 feet (sampling interval will depend on heterogeneity and thickness of the sandstone beds).*
    - *Tight rock analysis porosity measurements on whole core/rotary core samples from the confining zones every 5-10 feet.*

## 7.4 Objectives for Pre-Operational Testing:

- Obtain laboratory core data on porosity at the Mendota site for the injection and confining zones to confirm the representativeness of the available data from nearby oil fields, support calibration to well logging data, and support development of the porosity distribution in the geomodel.
- Obtain core and well log data that will help identify vertical heterogeneity in porosity.
- Obtain well logging data to support log-based porosity calculations and calibration to core analyses.
- Verify estimates of irreducible water that were presented in the permit application.
- Please refer to previous responses to the objectives for pre-operational testing for details on the core and well log data to be acquired and what information will be provided by the analysis/ses performed on the core.

### **Permeability**

The Panoche Formation permeability estimates range from 300 mD in the First Panoche Sand to 87 mD in the Fourth Panoche Sand (Table 3). Estimated average permeability in the primary injection zone, the Second Panoche Sand, is 290 mD (page 39). The Moreno Shale is estimated to have an average permeability of 4.7 mD (page 39).

Page 38 of the application states that: “The intrinsic permeability was estimated based on the porosity and lithology of the formation (Herron, 1987) using the wells around Mendota\_INJ\_1 (Figure 29). The lithology model consisted primarily of Quartz, Clay and Feldspars based on the core from NAPA AVE A/1. The relationship of porosity vs permeability is show in Figure 30. The average permeability of both the injection and confining zones is shown in Table 3 and Figure 31 shows the spatial variations in permeability thickness (KH) for the different formations.”

## 7.5 Questions/Requests for CES:

- How many analyses for permeability are proposed to be performed with cores from drilling of the proposed injection well and observation well?
- Two different permeability analyses are recommended to be performed on the core samples:
  - Basic steady-state gas permeability measurements on injection zone whole core/rotary core samples, every 2-3 feet (sampling interval will depend on heterogeneity and thickness of the sandstone beds).
  - Pulse-decay permeability measurements on whole core/rotary core samples from the confining zones every 5-10 feet.
- The text mentions “facies logs” (e.g., on page 40). Does this refer to the VCL data derived from the well logs?
- The facies log mentioned on page 40 refers to the simple facies log derived from VCL using a 30% cutoff.

## 7.6 Objectives for Pre-Operational Testing:

- *Obtain laboratory core data on permeability at the Mendota site for the injection and confining zones to confirm the representativeness of the available data from nearby oil fields, support calibration to well logging data, and support development of the permeability distribution in the geomodel.*
- *Obtain well logging data to support log-based permeability calculations and calibration to core analyses.*
- *Obtain core and well log data that will help identify vertical heterogeneity in permeability.*
- *Please refer to previous responses to the objectives for pre-operational testing for details on the core and well log data to be acquired and what information will be provided by the analysis/ses performed on the core.*

# 8 Mineralogy, Petrology, and Lithology of the Injection and Confining Zones

The Panoche Formation consists of layers of deep marine shale and submarine fan deposit intervals (page 15). Although the target injection zones are the First and Second Panoche Sands at the proposed injection site, CES bases their description on a core sample from the Fourth Panoche Sand (Depth: 11,422 – 11,471 ft) taken at the B.B. Co Well 1 located 2.32 miles from the storage site. (page 64; Attachment B, page 20). The Panoche Sands contain a mixture of sandstone and conglomerate. The sandstone contains mostly coarse, poorly sorted quartz and feldspar grains, cemented by calcite. There is also an abundance of biotite with low amounts of chlorite, muscovite, and pyrite (page 64). This analysis is consistent with a sample taken from NAPA AVE A/1 located 9 miles from the site at depths between 8,200-8,751 ft, roughly correlating with the depth of the proposed injection zone (page 34).

Table 4 shows that the lithology of the NAPA AVE A/1 sample, obtained through core X-Ray Diffraction (XRD) consists primarily of quartz, clay, and feldspars (page 39). Uncertainties include lateral conformity to the site, leading to potentially different mineralogy and reservoir properties. CES plans to sample a core at a characterization well (page 27). CES has done initial geochemical modeling to address the potential for mineral precipitation and dissolution, with possible changes in porosity and permeability. Future cores should include samples from the confining layers, with measurements of mineral composition.

## 8.1 Questions/Requests for CES:

- *The NAPA AVE A/1 sample is taken at a depth that correlates to the injection zone. On page 18, it is noted that the sand and shale facies vary in lateral extent and thickness. Is there additional evidence indicating that the injection zone sample taken from NAPA AVE A/1 is analogous to the site injection zone?*
- *As explained in the response to a question on comparability of sandstones across the wells in the Geomechanics and Petrophysics Section 7, there is uncertainty in the depositional setting in the study area. Published reports (Hosford Scheirer & Magoon, Petroleum Systems and Geologic Assessment of Oil and Gas in the San Joaquin Basin Province, California, 2007) describe a progradation from east to west from deltaic to channel and fan slope facies along the eastern edge of the basin. Based on the regional maps, written descriptions and conceptual diagrams it is likely*

*that Panoche sandstones described for the proposed Mendota\_INJ\_1 well are part of the slope channel and fan complexes; however, the possibility that the well location could intersect sandstones in the more distal parts of the deltaic sequence. The USGS report states that the sandstones in these two depositional environments are coeval in which case it is reasonable to assume that the provenance for the slope channel and fan sandstones are from the deltaics up-dip. Digital log responses from 10 nearby wells show the Second Panoche Sandstone below the regionally correlatable First Panoche Shale are consistent. The sandstones in the NAPA AVE A/I well lie on a parallel trend with Gill Ranch sandstones, which are interpreted as deltaic, and therefore are likely to be similar in depositional setting. Although the proposed injection well is more distal and possibly in the fan channel setting, the similar ages of the sandstones, their comparable log properties and expected similar petrology regardless of the depositional setting suggests a similarity in properties between wells. There are likely some property differences; however, given the greater depth of burial and expected higher compaction, in the sandstones in the proposed injection well site to the NAPA AVE A/I well, it is not expected that these differences will be significant.*

## 8.2 Objectives for Pre-Operational Testing:

- *Obtain core samples during drilling of the proposed injection well and deep monitoring well to characterize the mineralogy and lithologies of the injection and confining zones at the Mendota site.*
- *Please refer to previous responses to the objectives for pre-operational testing for details on the core and well log data to be acquired and what information will be provided by the analysis/ses performed on the core.*

# 9 Seismic History and Seismic Risk

The Mendota site is located near the center of the San Joaquin Basin, which is less tectonically active than the margins of the basin. Historical earthquake data were obtained from the USGS Earthquake Hazards database. All earthquakes in the region since 1900 with a magnitude greater than 2.5 were taken into account. Major fault systems in the region include the San Andreas Fault approximately 40 miles to the southwest and the San Joaquin and Ortigalita fault systems approximately 15 to 20 miles to the south and west. The nearest cluster of quakes, all less than 5.0 magnitude, occur along the San Joaquin and Ortigalita faults and are shown on the map in Figure 42. The largest nearby quake was the Coalinga Quake with a magnitude of 6.7 in 1983, located approximately 36 miles south of the Mendota site (page 53). The nearest to the Mendota site were three small quakes (<3.0 magnitude) between ~2.5 to ~5 miles away; the most recent of these occurred in 1998 (Figure 43). The application states that the relative risk of the proposed site is low compared with the active zones associated with major faulting (page 53). In order to more fully assess seismic risk at the Mendota site, more information will be needed about local stresses and fracture networks (page 54).

## 9.1 Questions/Requests for CES:

- *The application, on page 53 states, that the “relative risk of the proposed site is low compared with the active zones associated with major faulting.” Please clarify how the seismic risk profile for the site will be quantified, particularly in the context of a seismically active region.*
- *The natural seismicity at the Mendota site is relatively much lower when compared to other*

*regions in the San Joaquin Basin. The seismic risk profile will be quantified using historical data (from the USGS and CEMA), interpretations from the 3D seismic, wellbore FMI measurements and geomechanics measurements on whole core/rotary core samples (which can help delineate potential failure of the rock). Microseismic monitoring will also be used to first establish a baseline prior to injection and continuing during the injection period. The local stress field and fractures will be quantified using caliper logs, core and FMI interpretation collected during and after drilling. Seismic activity will be actively monitored throughout the injection period.*

## 9.2 Objectives for Pre-Operational Testing:

- *Incorporate geomechanical information (dipole sonic logs), formation microimager (FMI) logs, and micro-seismic monitoring into the analysis of seismic risk to inform setting of operating conditions and emergency response planning.*
- *Please refer to previous responses to the objectives for pre-operational testing for details on the core and well log data to be acquired and what information will be provided by the analyses performed on the core.*

# 10 Facies Changes in the Injection or Confining Zones

The facies descriptions and depositional history as described in the permit application are consistent with the presence of interbedded shales and submarine fan deposits, including a lenticular shape for the sandstone units.

The description of the lithology from the B.B. Co 1 well is at a depth corresponding to the Fourth Panoche Sand. Figure 5 in the application narrative, however, shows the Second Panoche Sand as the primary injection formation, with the Fourth Panoche Sand as an optional formation. Given the latter, and the vertical heterogeneity inherent in a shallow marine environment with turbidites and shallow marine shale facies, the lithologic characteristics of these two sands and the surrounding shales at the Mendota site will need to be confirmed during the pre-operational testing program. This would help identify any facies changes that could provide potential preferential flow paths (i.e., high permeability zones) or otherwise affect containment and fluid movement.

CES has indicated that 3D seismic profiling and a characterization well will help in assessing the extents, thicknesses, and lithologies of the injection and confining zones.

## 10.1 Objectives for Pre-Operational Testing:

- *Characterize the geologic units, including the geometry, thicknesses, and extents of the sand and shale units and confirm that these are consistent with current understanding of the depositional history and facies changes expected at the Mendota site based on the 3D seismic survey.*
- *Detailed lithologic descriptions will be collated of the slabbed whole core through the Panoche sandstone beds that will identify the vertical extent of the facies and facies changes. The core data and log data will be incorporated with 3D seismic interpretation to determine the geometry, thickness and the extent of the facies.*

- *Determine if there are any heterogeneities within the Second Panoche Sands that could affect its suitability for injection, including facies changes that could facilitate preferential flow.*
- *The tools described above will address this requirement.*
- *Collect seismic, core, and well logging data that will support characterization of subsurface heterogeneity and refinement of a refined geomodel.*
- *Please refer to previous responses to the objectives for pre-operational testing for details on the core, well log and 3D seismic data to be acquired and what information will be provided by the analyses performed on the core.*

## 11 Structure of the Injection and Confining Zones

The Panoche Formation and the Moreno Shale formations were deposited at the same time as the Great Valley deposits in the east and pinch out against basement rock to the east as shown in Figure 3 and Figure 4 (Bartow, 1990) (Scheirer, 2003). It is difficult to confirm the pinch out as a sealing factor from Figure 4 (page 16). CES states that models of depth, thickness, and areal extent of the injection and confining zones were created using well and 2D seismic data that were incorporated into a geomodel in Petrel (page 33). Future cross sections should show an aerial view with transects labeled.

The current information on the general geometry of Fault 13 is shown in Figure 22. There are, however, uncertainties regarding its characteristics (e.g., displacement, sealing capabilities). CES plans to clarify the fault's location and characteristics.

CO<sub>2</sub> plume simulations show the plume migrating up-dip to the northeast, away from Fault 13 (page 27). The regional dip of this and other formations is noted as being about 4 degrees to the southwest (page 18; Figures 16 and 17). On page 71, however, the text states that "...The regional dip of this [the Panoche] and other formations is to the northeast; this implies that the injected CO<sub>2</sub> will migrate approximately 2 miles to the northeast (Section 3)." The text on page 71 may be in error as it is inconsistent with other sections of the text and with the figures and cross sections.

### 11.1 Questions/Requests for CES:

- *Please clarify if the text on page 71 regarding the dip to the NE is in error as it is inconsistent with discussion in other sections and with several figures.*
- *This was an error; the text should state that the stratigraphic beds dip southwest towards basin axis.*
- *What are the primary mechanisms for lateral confinement? Is it based solely on sand pinch out? If so, please provide evidence to confirm the pinch out as a sealing factor (as this is not entirely clear in Figure 4).*

- *The primary mechanism for lateral confinement based on the dynamic modeling is post-injection, buoyancy and capillary forces stabilizing the injected CO<sub>2</sub> plume over time. This process does not require a physical low permeability lateral barrier up-dip. Regional mapping indicates lateral stratigraphic pinch outs are likely in up-dip shales from the proposed injection site providing a secondary lateral seal. This assumes that the sandstones in the injection well are related to the channel/fan complexes on the Cretaceous slope. As explained previously, there is some uncertainty in the depositional setting as the proposed reservoir sandstones could be part of the distal deltaic sequence. Figure 2, for example shows several conceptual depositional models for the Cretaceous facies distribution from the northern San Joaquin basin with the distal Lathrop sandstones (likely first and second Panoche) pinching out in the Moreno Shale up-dip, which are likely basin floor fans. Channelized sandstones feeding the basin floor fans are further up-dip across the Cretaceous slope with much of their lateral margins encased in shale. The site of the injection well is likely in this up-dip part of the channel sandstone complex; however, due to uncertainty in the regional interpretation it is possible that the targeted sandstones are part of the distal deltaic Starkey sandstones up-dip or that slope channels connect creating a connected permeable sandstone pathway. Because of this uncertainty a conservative approach has been taken for geomodeling with sandstones mostly homogenous and connected throughout the model. Using this approach dynamic modeling results show that the plume is constrained by in-situ capillary controls. During injection, pressure gradient is the most significant factor to determine the lateral and vertical migration. Sequence stratigraphy and lateral confinement will be better understood once 3D seismic data is acquired and lithocube analysis performed.*
- *To what degree are the faults expected to affect lateral confinement?*
  - *Preliminary fault seal analysis shows that displacement across Fault 13 is low, indicating that potential for communication between sandstone zones (stratigraphically separated by shales) is unlikely. Additional fault interpretation using 3D seismic data and modern pressure data will help determine whether faults exist in the AoR and if they will affect lateral confinement.*

## 11.2 Objectives for Pre-Operational Testing:

- *Verify fault locations and sealing properties based on the results of the 3D seismic survey.*
  - *A 3D seismic survey will be acquired to verify fault locations, the extent of faulting, and the sealing properties. Sealing properties will be estimated from fault seal analysis using techniques such as shale gouge ratio.*
- *Confirm the lateral thickness and homogeneity of injection targets.*
  - *The lateral thickness and homogeneity of the injection targets will be confirmed upon acquisition of 3D seismic, well log and core data.*

## 12 CO<sub>2</sub> Stream Compatibility with Subsurface Fluids and Minerals

Section 2.8.4 (page 65) and 2.8.5 (page 66) describe the geochemical model setup and reaction path simulations that were performed to assess interactions between the injectate and the formation solids and fluids. Modeling was done using the geochemical modeling program Geochemist's workbench.

CES notes that the simulations show a net reduction of rock mass and volume. This would result in increased porosity and (potentially) permeability.

CES should update the initial geochemical modeling effort when new data on fluid chemistry and mineralogy are available from the formation testing. Potential effects of water-rock interactions on porosity and permeability may require more refined modeling and will not be fully known until the operational phase of the project.

## 12.1 Questions/Requests for CES:

- *Will the autoclave testing mentioned in the application or any other laboratory experiments be conducted to help refine the modeling?*
- *Autoclave CO<sub>2</sub>-water-rock reaction experiments can be conducted with core and water samples taken from the injections. The core samples can be analyzed before and after the experiment to quantify the effects of mineral reactions on flow and geomechanical properties. Aqueous chemistry data from the experiments will be used to calibrate geochemical modeling.*
- *Will surface area (BET) measurements be done to refine the modeling?*
- *BET measurements on the core samples is recommended.*

### *Objectives for Pre-Operational Testing:*

- *Generate fluid chemistry and mineralogic data, pressure, temperature, and pH conditions at depth via core sampling and formation testing in the characterization and monitoring wells to provide inputs to the geochemical modeling.*
- *Various water and core analyses will be obtained to assist with the geochemical modeling.*

## 13 Confining Zone Integrity

The integrity of the upper confining zone (Moreno Shale) is based on the thickness and continuity of the unit from seismic and other information, the presence and properties of faults and fractures, and information on petrophysical and lithologic characteristics from available core and well log data. According to the isochore maps in Figure 13, the Moreno Shale ranges from 800-1,650 feet thick in the proposed AoR (page 40). This will be confirmed during testing.

The current porosity and permeability estimates for the Moreno Shale are 8% porosity and 4.7 mD for permeability (Table 3). The porosity appears low and the permeability appears somewhat high for a shale. These need to be confirmed with site-specific data collected during pre-operational testing. Other parameters relevant to confining zone integrity include the capillary entry pressure, which was estimated using the Van Genuchten model because of the absence of laboratory measurement (page 50). CES notes that other tests to assess confinement zone integrity include formation microimage log measurements and drill stem testing (DST) or Modular Dynamics Tester (MDT) stress testing (page 50).

### 13.1 Objectives for Pre-Operational Testing:

- *Confirm mineralogy, porosity, permeability, capillary entry pressure, and geomechanical properties*

*of the Moreno Shale based on core sampling and laboratory measurements to confirm that the Moreno Shale will retain its integrity at planned operating conditions (i.e., injection pressures).*

- Shale petrophysical and geomechanical characteristics will be confirmed via core sampling and laboratory measurements.*
- Obtain well log data from all shale units that can provide containment to allow log-based estimates of VCL, porosity, permeability, and TDS.*
  - A variety of well log data will be obtained, including but not limited to Triple Combo logs (Density, Neutron, Resistivity), specialty tools to measure porosity, permeability and the amount of minerals in the formation, sampling and pressure tools, compressional and shear sonics, and borehole imaging, etc.*
- Test for changes in capillary entry pressure due to reaction of the shale with the injectate via laboratory experiments.*
  - Threshold entry pressure tests can be used to test for changes of the capillary entry pressure on whole and rotary core.*
- Determine the fracture pressure of the Moreno Shale.*
  - Because of the nature of the fracture test and to avoid caprock damage (Moreno Shale) the test is recommended to be done in the injection zone, whilst still providing valuable stress calibration point. Alternatively, this test can also be conducted in the upper portion of the Moreno Shale.*
  - A geomechanical model with rock properties calibrated to geomechanical core test data will be used to provide an estimation of fracture pressure via the poroelastic stress equation. This is performed continuously along the well trajectory, including the Moreno Shale. The fracture pressure estimation can be further refined and validated through field test measurements such as step rate or Diagnostic Fracture Injection Test (DFIT). In both cases a limited small volume of fluid is injected into the rock volume to initiate and propagate a small fracture which then closes as the pumps are turned off. The closure pressure of the fracture is a direct measurement of the fracture pressure and can be used to validate the fracture pressure profile estimated from the poroelastic stress equation.*

## 14 References

- Conservation, C. D. (1998). *CALIFORNIA OIL & GAS FIELDS Volumes I, II, & III*.
- Hosford Scheirer, A., & Magoon, L. (2007). *Age, distribution, and stratigraphic relationship of rock units in the San Joaquin Basin province, California*. USGS Professional Paper 1713.
- Hosford Scheirer, A., & Magoon, L. (2007). *Winters-Domengine Total Petroleum System - Northern Nonassociated Gas Assessment Unit of the San Joaquin Basin Providence*. USGS Professional Paper 1713.
- SEI. (2019). Seismic Exchange Inc.
- USGS. (2018). *Preliminary Groundwater Salinity Mapping Near Selected Oil Fields Using Historical Water-Sample Data, Central and Southern California*.
- USGS. (2019). *USGS Mineral Resources*. Retrieved from <https://mrdata.usgs.gov/geology/state/state.php?state=CA>

## 15 Appendix A: Updated Figures

**The following Figures have been removed as they contain Confidential Business Information. These images will be sent directly to the EPA.**

Figure 4: **CONFIDENTIAL BUSINESS INFORMATION:** W-SJ-202 2D seismic line (depth) with interpreted horizons and faults. This image displays (SEI, 2019) data and it is marked as Confidential Business Information.

*Figure 5: **CONFIDENTIAL BUSINESS INFORMATION:** W-SJ-209 2D seismic line (depth) with interpreted horizons and faults. This image displays (SEI, 2019) data and it is marked as Confidential Business Information.*

*Figure 6: **CONFIDENTIAL BUSINESS INFORMATION:** W-SJ-013W 2D seismic line (in depth) with interpreted horizons and faults. This image displays (SEI, 2019) data and it is marked as Confidential Business Information.*

*Figure 7: **CONFIDENTIAL BUSINESS INFORMATION:** 3D View (facing SE) of interpreted faults on the 2D seismic lines and Basement surface. Dotted lines are projected faults (color coded by horizon) or projected fault plane. A legacy Gill Ranch field structure map is inserted at the Second Panoche. This image displays (SEI, 2019) data and it is marked as Confidential Business Information.*

*Figure 45: **CONFIDENTIAL BUSINESS INFORMATION:** USDW estimated using resistivity measured in wells near the Mendota site. This image displays (IHS, 2019) data and it is marked as Confidential Business Information.*

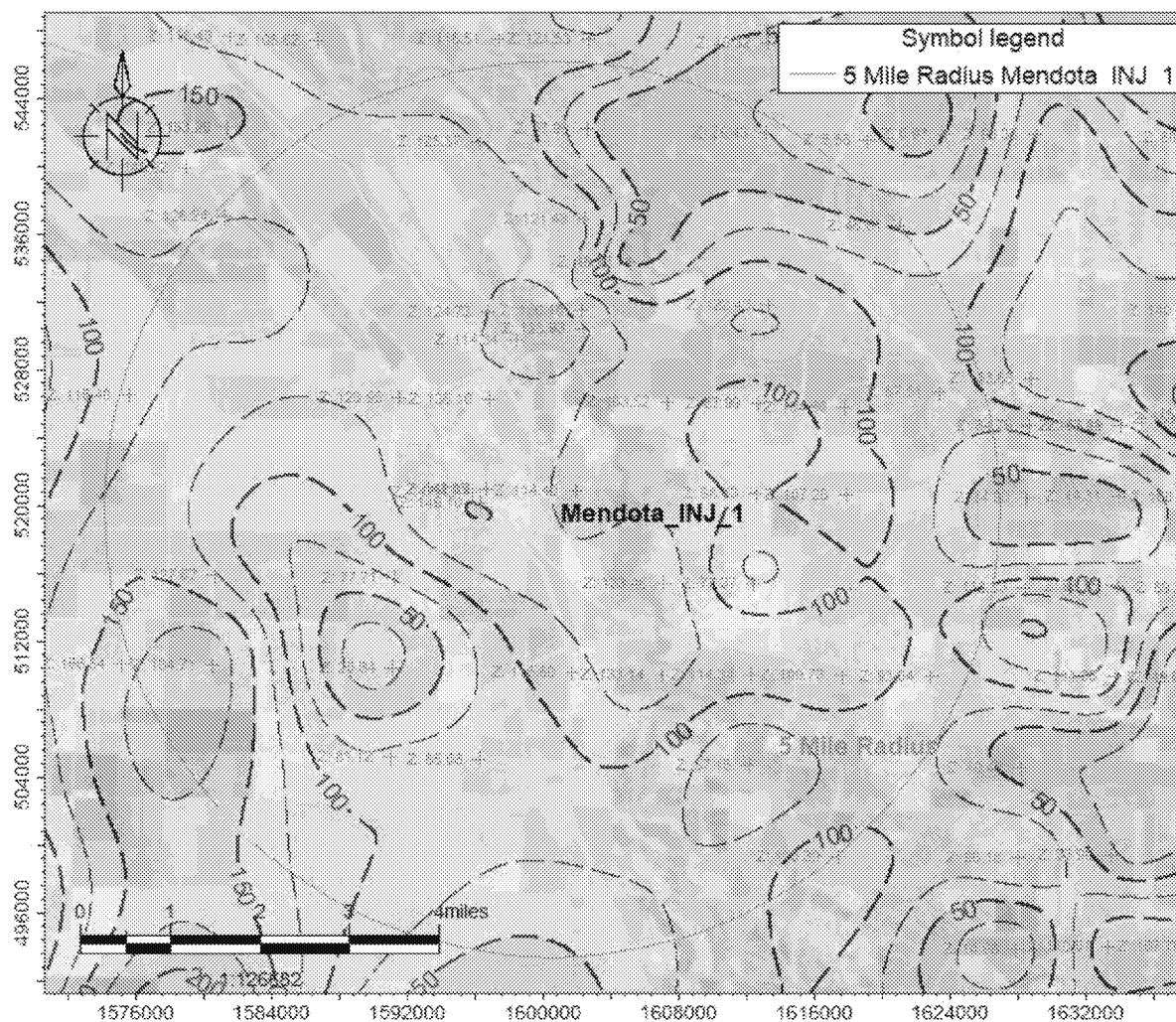


Figure 47: Potentiometric map of the approximate shallowest groundwater surface

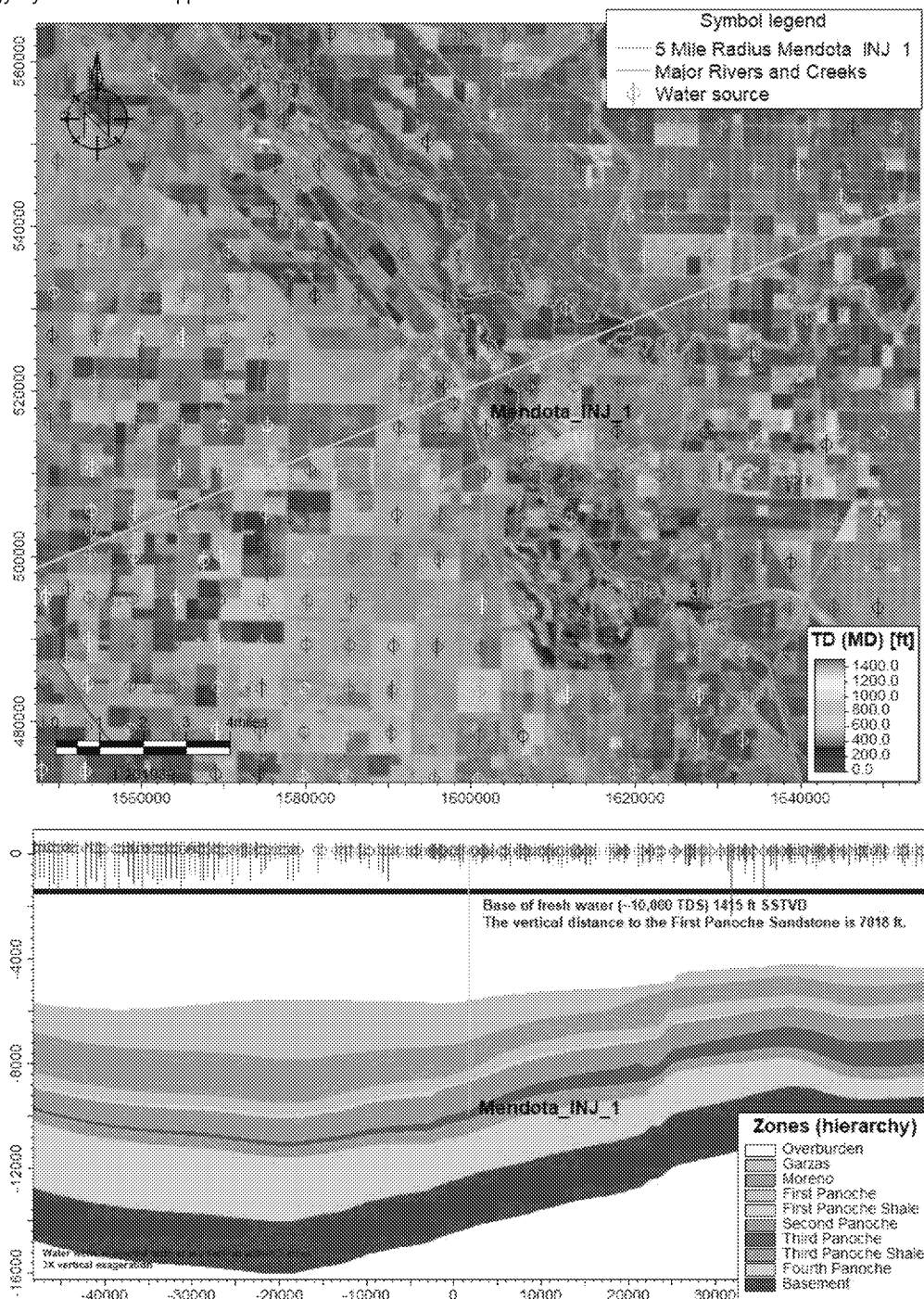


Figure 46: Water well and surface water

## 16 Appendix B: Support Requirements: Endangered Species Act



# **LIVE OAK ASSOCIATES, INC.**

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an Ecological Consulting Firm

September 28, 2020

Larry Trowsdale  
Clean Energy Systems, Inc.  
3035 Prospect Park Drive, Suite 120  
Rancho Cordova, CA 95670-6071

**RE: Scope and Budget for Biological Resource Survey and Report for the CES Mendota Biomass Power Plant Project in Mendota, Fresno County, California.**

Dear Mr. Trowsdale:

Per your request, Live Oak Associates, Inc. (LOA) has prepared this scope and budget to conduct a biological resource survey and report for the CES Mendota Biomass Power Plant Project in Mendota, Fresno County, California. This work will address biological resource issues as required by the California Environmental Quality Act (CEQA) and the Endangered Species Act (ESA).

LOA has reviewed the RFP materials, email clarifications, site location, and IPaC resource list from the U.S. Fish and Wildlife Service for the project. Surveys and documents produced for this project will follow CEQA and EPA requirements. As we understand it, the proposed biological surveys and evaluations are planned to take place over at least two phases. The focus of Phase 1 will be on-the-ground biological surveys and evaluation of the 71-acre Mendota biomass plant site and a desk-top evaluation of the projected plume area as provided in the RFP materials; together, these areas have been identified as the Area of Review (AOR). At the time of this proposal, the AOR boundary has not been solidified, however the RFP materials did provide a figure for reference. Phase 2 includes biological surveys and evaluations of multiple monitor well sites within the projected plume area as well as multiple seismic testing wells both within and beyond the projected plume area. As the number and locations of well sites Phase 2 may encompass is yet to be determined, the scope and budget of Phase 2 within this proposal cannot be precisely determined, therefore, we have included some guidelines and approximations for the scope and budget for Phase 2 surveys and reports.

**PHASE 1: MENDOTA BIOMASS SITE EVALUATION AND DESKTOP EVALUATION FOR PROJECTED PLUME AREA**

Phase 1 consists of a full evaluation for the 71-acre Mendota Biomass site as well as a desktop evaluation for the projected plume area. It is important to note that the projected plume area and AOR have yet to be solidified at the time of this proposal and will be evaluated at a programmatic level during Phase 1. The results of Phase 1 will inform CES in order to help CES to determine specific well sites; those well sites, once identified, will be further evaluated during Phase 2.

**Task 1a. Project Management.** Due to the complexity in managing and scheduling for this project, some amount of time has been budgeted for project management.

**Task 1b. Background and Desktop Evaluation.** LOA will review all available databases and sources of information relevant to the project vicinity. This includes aerial photographs of the project site, USGS topographic maps, U.S. Fish and Wildlife Service National Wetland Inventory Maps, the California Natural Diversity Database, other technical literature related to the biotic resources of the project vicinity, regional planning documents (e.g., City of Mendota policies, etc.), species data compiled by the California Native Plant Society, the National Audubon Society, or other public interest groups, and resource agency data (e.g., U.S. Fish and Wildlife Service and the California Department of Fish and Wildlife). Additional focus will be given to a programmatic desktop review of the projected plume area.

**Task 1c. Field Surveys.** An LOA wildlife ecologist and an LOA plant and wetland ecologist will conduct a field survey of the 71-acre Mendota biomass site. This survey will be used to identify habitats present onsite and to determine if the site supports potentially suitable habitat for any special-status plant or animal species which are known to occur regionally. Issues related to any special-status habitats or species will be identified.

We are not proposing to conduct any species-specific surveys or a wetland delineation at this time as we believe the approach discussed above should adequately address (for CEQA purposes) the likely presence or absence of sensitive habitats and special status plant and animal species. Should any further assessments of the site become necessary or desired (e.g., species-specific surveys, wetland delineation, etc.) they will be covered under a separate scope and budget.

**Task 1d. Report Preparation.** The results of the field survey and background review and desktop survey will be compiled in a Biological Resources Report. This report will identify existing habitats on the site and presumed habitats within the plume area, discuss the suitability of the site and plume area to support habitat for special-status plant or animal species, identify potential impacts to biotic resources of the site, plume area, and region, recommend additional surveys (if appropriate), and give guidance as to what typical mitigation measures would be for any project impacts.

It is important to note that the report will be at a programmatic level for the plume area, as access would likely not yet be granted yet and we understand this report may be instrumental in determining well locations in order to avoid impacts to biological resources identified in the report.

**Phase 1 Schedule and Cost Estimate.** We propose to conduct Tasks 1a-1d on a time-and-materials basis for a not-to-exceed cost of [REDACTED]. The fieldwork for this project would be completed within three weeks of the notice to proceed and the Biological Resources Report would be completed within two weeks of the fieldwork. We expect 40% of the budget to be spent by the time the fieldwork is completed which would include the background, part of the desktop analysis, and part of the report writing. We expect the other 60% of the budget to be spent with the completion of the Biological Resources Report. An hourly rate sheet has been included with this proposal.

## PHASE 2: MONITORING AND SEISMIC WELL LOCATION EVALUATIONS

As the number and location of monitoring and seismic well locations are currently unknown, and we expect locations of these wells may be influenced by the results of Phase 1 work, the precise scope and budget cannot be determined at this time, however, we have included some guidelines and assumptions for the tasks related to the projected plume area, therefore, we have included an estimated cost for Phase 2 tasks within the scope stated in each task and allowed for additional budget should additional work become necessary. The following scope would only occur upon authorization of Clean Energy Systems, Inc. The following proposed scope constitutes Phase 2:

**Task 2a. Project Management.** Due to the complexity in managing and scheduling for this project, and due to the unknown magnitude of work related to Phase 2, we have allowed for 2 hours of project management time for our Principal and 5 hours of project management time for the Project Manager. Should a significant amount of additional project management time become necessary, that time would be billed on a time-and-charges basis.

**Task 2b. Field Surveys.** We assume all well locations will be accessible for field surveys within the same timeframe. For budgeting purposes, we have figured a maximum of 50 well locations and two field days for both an LOA wildlife ecologist and an LOA plant and wetland ecologist to survey these well locations. These field surveys will evaluate each of the proposed well locations, a suitable distance around each location, and the off-road access routes to those wells, if routes are known at the time of the survey. Due to the large size of the AOR and potential complexity of the well locations, this task also includes our cartographer producing field maps for ecologists prior to their field surveys. Should access to well locations take longer than two days, we have estimated [REDACTED] for each additional day needed to conduct the field surveys for all well locations.

We are not proposing to conduct any species-specific surveys or a wetland delineation at this time. Should any further assessments of the site become necessary (e.g., species-specific surveys, wetland delineation, etc.) they will be covered under a separate scope and budget.

**Task 2c. Biological Resources Report Addendum.** LOA will prepare an addendum report which is intended to be added as an attachment to the original Biological Resources Report which will document the results of the field surveys for the proposed well locations. This report will include a chart with each of the proposed wells and the measures in the Biological Resources Report which apply to each of them with. Maps within this addendum would focus on proposed well locations and any special status species or wetlands at or near the proposed well locations identified during the field surveys. This addendum will also identify any unforeseen issues related to biological resources not already identified by the original Biological Resources Report, and if any unforeseen issues are identified, the addendum report will include appropriate mitigation measures for those issues.

**Phase 2 Schedule and Cost Estimate.** We propose to conduct Tasks 2a-2c on a time-and-materials basis for a not-to-exceed cost of [REDACTED] with the potential for the additions of hourly cost over and above stated hours for Task 2a and an additional [REDACTED] for each day of field work added to Task 2b. The fieldwork for this project would be completed within three weeks of the notice to proceed and the Biological Resources Report would be completed within two weeks of the fieldwork. We expect 60% of the budget to be spent by the time the fieldwork is completed. We expect the other 40% of the budget to be spent with the completion of the Biological Resources Report Addendum. An hourly rate sheet has been included with this proposal.

**Meetings and Hearings.** We have not allowed time for additional conference calls, meetings or hearings. Should our presence be required at any such engagements, our time would be invoiced on a time-and-charges basis using our current billing rates.

We thank you for considering our firm and look forward to providing ecological services to you on this project. If you have any questions or concerns regarding this proposal, please contact me at your earliest convenience at (408) 281-5889 or Rick Hopkins at (408) 281-5885, at your convenience.

Sincerely,



Katrina Krakow, M.S.  
Project Manager  
Staff Ecologist

**Proposal Acceptance**

If you approve this proposal's scope of work, cost, Standard Terms and Conditions, please sign and return one copy of this proposal to our office at your earliest convenience.

Accepted By: \_\_\_\_\_ Date: 28-Sep-2020

Printed Name: Rebecca Hollis Title: Director BD - CNE

## 17 Appendix C: Support Requirements: National Historic Preservation Act



16 September 2020

Mr. Larry Trowsdale  
Clean Energy Systems, Inc.  
951 East Skylark Avenue  
Ridgecrest, CA 93555

**RE:** Mendota Carbon Capture Project, Mendota, Fresno County, California

Dear Mr. Trowsdale:

ASM Affiliates, Inc. is pleased to provide this proposal to conduct a Class III cultural resources inventory/Phase I survey for the Mendota Carbon Capture and Storage Project, Mendota, Fresno County, California. The proposed scope of services outlined below assists with fulfilling the regulatory requirements for compliance with the California Environmental Quality Act (CEQA) and Section 106 of the National Historic Preservation Act (NHPA), as amended, including those outlined by the Environmental Protection Agency. Our proposed scope of work, estimated cost, and schedule are described below. This proposal shall remain valid for 90 days from today's date.

### Scope of Work

David S. Whitley, Ph.D., RPA, will serve as Principal Investigator for the project. We will obtain a standard turn-around records search at the Southern San Joaquin Valley Information Center (IC), located at the California State University, Bakersfield, to identify any previously recorded sites located on or previous studies conducted within or adjacent to the project area. For the purposes of the records search, this will include the 71-acres biomass facility, the CO<sub>2</sub> plume Area of Review (AOR) and a half-mile buffer, as required for agency and SHPO compliance. The records search will include a review of all maps and files housed at IC related to the project areas, to determine whether they have been previously surveyed. During the records search, we will determine if any previously recorded cultural resources identified within the project area are listed on the National Register of Historic Places (NRHP) or the California Register of Historical Resources (CRHR).

A records search of the Native American Heritage Commission (NAHC) Sacred Lands files will also be requested. Outreach letters and follow-up phone calls will be made to tribal organizations and members on the NAHC-provided tribal contact list, to assist with the tribal consultation process.

Fieldwork will comprise of an intensive pedestrian survey of the approximately 71-acres biomass facility, using a 100-foot buffer. The survey will be designed to meet all professional requirements, including the Secretary of the Interior's *Standards and Guidelines*, and Office of Historic Preservation (SHPO) guidelines. Survey of this area will be conducted at 15-m transect intervals by qualified archaeologists.

Larry Trowsdale

9/16/2020

Page 2 of 3

Any newly identified sites or historic buildings or structures will be mapped and recorded on DPR 523 forms for submission to the IC for assignment of permanent trinomials. Previously recorded sites within the 71-acres biomass study area will be visited and the site form will be updated. If potentially significant archaeological sites or historic structures are identified during the survey, evaluation of their eligibility for the national, state or local register(s) may be required, if site avoidance cannot be achieved due to project constraints. Should this be the case, ASM will inform you of such and submit a proposal to complete that work.

ASM will prepare a written draft technical report that will summarize the background, research, methodology, historic context, and results of the work described above, including recommendations for NHPA Section 106 and CEQA compliance. The report will also include an assessment of the archaeological sensitivity of the AOR based on the records search results and existing geoarchaeological sensitivity studies.

### **Cost Estimate and Schedule**

The estimated cost to complete the records searches and Native American outreach, conduct the pedestrian survey, and prepare the technical report is [REDACTED]. We estimate that it will take approximately 3 - 4 weeks to receive the IC and NAHC records searches. The fieldwork will be completed within two weeks of the receipt of the records search. The draft report will be submitted within four weeks of the fieldwork.


For the purposes of this proposal, the following assumptions are made:

- The cost of the IC records search will not exceed \$ [REDACTED]
- No meetings on-site will be required;
- Field survey will be limited to the approximately 71-acres biomass facility;
- No Native American tribal monitoring will be included;
- The services of an architectural historian will not be required; and
- No archaeological sites or historical structures will be evaluated for significance.

If the cost of the IC records search exceeds [REDACTED] additional acreage requires survey, or the other assumptions cannot be met, we will work with you to augment our budget.

Should you have any questions or would like to discuss this project further, please do not hesitate to contact me.

Sincerely,



David S. Whitley, Ph.D., RPA  
Director

Larry Trowsdale  
9/16/2020  
Page 3 of 3

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RE: Mendota Carbon Capture Project, Mendota, Fresno County, California

Fixed Fee Cost: [REDACTED]

Accepted by:

*Rebecca Hollis*

Signature

Rebecca Hollis

Print Name

Director BD - CNE

Title

24-Sep-2020

Date

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